

of low pressure which extends over the whole of Central Asia. Air passes northward from the region of high pressure as the southwest trade winds so far as the equator, where it gets caught up in the circulation around the low pressure over Asia. On account of the particular arrangement of sea and land, combined with deflection of wind currents due to the earth's rotation, this air travels for 4,000 miles over the sea before it reaches India, where it arrives in a very warm and exceedingly humid condition. This air, however, would probably sweep right across India to its goal in central Asia without producing much rainfall if it were not for the unique distribution of mountains around India. From the north of the Mokran coast, right around India, following the line of Afghanistan, the Himalayas, and the mountains of Burma, there extends an unbroken wall of mountains, nowhere lower than 5,000 feet, standing directly athwart the air currents. The mountains catch the air, which is being driven by a pressure distribution extending from the Southern Indian Ocean to the center of Asia, in a kind of trap, out of which there is no escape except by ascension. The damp, humid air, which begins to rain as soon as it rises 500 feet, is forced to rise between 10,000 feet and 20,000 feet, and, in consequence, large masses of water are precipitated over the greater part of the Indian area.

STORM WARNINGS IN INDIA.

The Meteorological Department of the Government of India has issued its report on the administration in 1919-20. Observations in connection with the upper air have been developed on behalf of the aviators who are from time to time crossing India. Storm warnings for stations in the Bay of Bengal and in the Arabian Sea are said to have been carried out successfully. It is, however, admitted that the warning of the storm which caused much damage to life and property in eastern Bengal on the night of September 24, 1919, was inadequate. Inland stations were not communicated with until early evening, and were then informed that a "slight to moderate storm" was expected. Special arrangements have been made to avoid the repetition of a similar mishap. The storm, which was tracked from September 22-25, developed rapidly as it approached, and crossed the Bengal coast as a cyclone about noon on September 24. It reached Dacca at about 2.30 a. m. on September 25, and finally broke up on that day in the Assam hills. At the center the deficiency of pressure was about $1\frac{1}{4}$ inches, and the calm area at least 15 miles in diameter. The total loss of life is estimated at 3,500. The value of property destroyed was probably greater than in any storm in Bengal for the last 200 years, but the destruction of human life was probably greater in the Bakarganj cyclone of 1876. An additional terror was caused by a vivid red glow appearing in the sky during the period of the lull. Details are given of the several storms which occurred during the year. Flood warnings are issued and the results are said to be very satisfactory. Rainfall data were received for publication from nearly 3,000 stations for the year.—*Nature (London)*, April 28, 1921, pages 279, 280.

OCEAN SURFACE-CURRENTS INDICATED BY DRIFT-BOTTLES AND OTHER OBJECTS.¹

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During the summer of 1919 the Biological Board of Canada set out 330 drift bottles in the Bay of Fundy. Sixteen of these have been picked up on the shores of the Gulf of Maine. Each bottle contained a Canadian postcard on which was printed besides the address of the Biological station, the offer of a reward to the finder who wrote the time and place of finding, and posted the card. Two sizes of bottles were used—2-oz. and 8-oz.; to the latter a galvanized-iron drag was attached to hang at a depth of 3 fathoms, the object of the drag being to minimize the direct effect of the wind. Of the 55 bottles with drags, three were picked up on the Cape Cod peninsula, and three on the Maine coast. Of the 275 bottles without drags, eight were found on Cape Cod and two on the Maine coast. Seven of the bottles (of both sizes) which reached Cape Cod were found after an elapse of between 73 and 80 days. The direct distance between the Bay of Fundy and Cape Cod is 300 nautical miles. This gives an average daily drift of about 4 nautical miles.

The drift of these bottles indicates a surface movement of the water from the Bay of Fundy through the northwestern part of the Gulf of Maine, striking Cape Cod.

On August 29, 1919, drift bottles were set out off the coast of New Brunswick, one of them reaching the Azores on August 8, 1920. From the position in which this bottle was found it is believed that it approached the Azores from the north or northwest. Another bottle, dropped only a mile from the first one and at about the same time, was carried to the Cape Cod coast. It is presumed that the first bottle approached Cape Cod, but being a little farther east was eventually caught by the Gulf Stream and carried to the Azores as just related.

Still a third was put out at the same time about 6 miles northeast of that which went to the Azores. It was picked up on one of the northwestern islands of the Orkney group, on January 21, 1921.

According to the *Toronto Daily Star*, November 1, 1920, a sealed bottle cast into the ocean near Newfoundland in September, 1919, reached Nieuport, Belgium, in August, 1920.

A striking case of drift cited by Mr. Mavor was that of the derelict schooner, *Fannie E. Wolston*, which was adrift for two and a half years and was observed over 30 times. On December 15, 1891, she was seen in lat. 36° N. and long. 74° W. (northeast of Cape Hatteras), and four times afterward on her way across the Atlantic, until she reached lat. 35° N. and long. 39° W. on June 13, 1892, having covered in six months four-fifths of the course between the American coast and the Azores. After reaching the Azores she circled the Sargasso Sea and returned to the American coast by a southern route.

The following account (from the *Washington Times*, August 9, 1920) of the drift of one of the life belts of the ill-fated *Lusitania* furnishes an interesting case of the action of the ocean surface-currents:

PHILADELPHIA, August 7, 1920.—Scientists are greatly interested in the probable route followed by the *Lusitania* life belt recently picked up in the Delaware River off one of the city piers in the center

¹ Abstracted from *Science*, New York, Nov. 5, 1920, pp. 442-443, Feb. 25, 1921, pp. 187-188, and Apr. 23, 1921, p. 389: communications from James W. Mavor.

of Philadelphia. They estimate it traveled from 12,000 to 15,000 miles and required more than five years in its journey.

The *Lusitania* was torpedoed off the Irish coast on May 7, 1915. Hydrographers figure that the belt went through the Irish Sea and around the north of Scotland; down through the North Sea and the English Channel; down the coast of France and Spain and Africa. There the current bore it across the Atlantic. Entering the Gulf Stream, it was carried north. It escaped from this current and drifted to the Delaware capes. Probably the propeller of a steamship caught it up at the capes and brought it up the Delaware. When found afloat it was 100 miles up the river from the capes.

The life belt was covered with barnacles. When these were scraped off the name of the *Lusitania* was found and easily deciphered.

—H. L.

THE METEOROLOGY OF THE ANTARCTIC.

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By G. C. SIMPSON.

[Excerpted from a review of Vols. I-II of the *British Antarctic Expedition, 1910-1918*, published in *Nature*, (London), Dec. 23, 1920, pp. 526-528.]

It was a fortunate day for meteorology when Capt. Scott invited Dr. Simpson to join his last expedition as meteorologist. The Antarctic has always provided a fascinating field on account of the symmetry of its general circulation combined with remarkable local phenomena; but never before has a meteorologist and physicist of the first rank studied Antarctic meteorology on the spot and presented to the world the digested results of observations planned and executed by himself.

* * * The main discussion is divided into nine chapters dealing with temperature, wind, cloud, and precipitation, pressure and its relation to winds and weather, general circulation, the upper air, the height of the Barrier and the plateau, and atmospheric electricity. Each chapter contains not merely a discussion of the results of the observations and a rational explanation of the facts revealed, but also some new contribution (such as, for example, a study of the gustiness of the wind) which was rendered possible only by the new instruments and methods not previously available in Antarctic work.

The annual and diurnal variations of temperature are shown to be, on the whole, due to insolation, but two features present difficulty. There is a diurnal variation of temperature during the months when the sun is completely below the horizon, and the "day" hours are, on the whole, warmer than the "night" hours. No rational explanation is given of this effect. The suggestion that it arises from scattered radiation from the upper layers of the atmosphere which come into the sunshine during the "day" hours is not mentioned, and it appears to be excluded by the fact that the effect is more marked on cloudy than on clear days, and by the further fact that on clear days there are two maxima at about 4 a. m. and 4 p. m., the time of minimum pressure in the semi-diurnal barometer oscillation. The unusual feature in the annual variation is roughly this: On the Barrier the amplitude of the variation is "oceanic" and the phase "continental," while in the Arctic the amplitude is "continental" and the phase "oceanic." The explanation put forward is, roughly, that the continents of Asia and America control the amplitude in the Arctic Ocean, and the Antarctic Ocean controls the amplitude on the Barrier; the argument is well stated, but it is not entirely convincing.

The records from the Dines pressure-tube anemometer, many of which are reproduced, add greatly to the interest of the chapter on wind, and, indeed, to that on temperature, too, by the light they throw on blizzards and other sudden changes. The winds at Cape Evans were found to be about 50 per cent more gusty than the winds at

Scilly and Holyhead; but the gustiness decreased as the speed of the wind increased, indicating, according to Dr. Simpson, that the high value was due, not to the exposure, but to the interaction between a warm upper current and a cold surface layer which are coexistent in the Antarctic more frequently than in England.

Pressure waves traveling outwards from the center of the continent are Dr. Simpson's contribution to the explanation of the synoptic charts of the Antarctic. He rejects Lockyer's scheme of traveling cyclones, and pours scorn on the suggestion that the motion of the air in a blizzard is part of a very large cyclonic system. "A depression with its center in 60° S. able to produce a blizzard of 40-60 miles per hour in 78° S. is of course quite inconceivable. Whatever blizzards may be due to, they are certainly not part of the circulation around a cyclone the center of which is more than 1,000 miles away." He appears here to be doing less than justice to Lockyer's scheme, which may represent the broad features of the pressure distribution, even although all the cyclones do not adhere rigidly to the sixtieth parallel of latitude.

The theory of pressure-waves will undoubtedly provoke much discussion; facts are marshalled in an imposing array to support it, and theoretical synoptic charts are produced which are wonderfully similar to the charts based upon actual observations. The pressure waves are apparently not sound waves; they are described as "true pressure waves traversing the upper atmosphere in the same way that water waves travel across the sea"—i. e., they are waves formed at a surface of discontinuity. As the waves appear to be at least 500 miles from crest to trough, there can not be very many of them—probably, in fact, not more than one—in existence at a time, so that the comparison ought to be with one long wave in shallow water (e. g., a tidal wave) rather than with "water waves traveling across the sea"; it appears doubtful if it is possible at the surfaces of discontinuity, which certainly exist in the Antarctic, to get waves 500 miles long traveling at 40 miles per hour, and having pressure amplitudes of 20 millibars at sea level. The horizontal transference of a large mass of air naturally suggests itself as an alternative explanation, but the adjustment of the motion to the pressure gradient presents difficulties.

In his discussion of the general circulation Dr. Simpson arrives at conclusions agreeing in some respects with Hobbs, and in others with Meinardus. Broadly speaking, he makes the whole continent an anticyclonic area surrounded by a broad band of low pressure about latitude 65; but at 10,000 feet the plateau alone is anticyclonic, while a very marked cyclone is centered over the part of the Antarctic which is near sea level. The upper winds deduced from cloud observations and from Erebus's smoke fit in well with the scheme.

The free atmosphere over the Antarctic had never been explored before Dr. Simpson sent up his *ballonsondes*; the results of this first attempt are remarkably good, although the stratosphere was not reached. Out of 21 ascents, 14 instruments were recovered, of which 12 furnished good records; but three of them referred to different times on one day, November 19, 1911. In six cases of summer ascents the temperature decreased steadily upwards at a rate of about 6° C. per kilometer; in four cases of winter ascents temperature rose at the commencement of the ascent, and began to fall only after a height of one or two kilometers had been reached. The lowest temperatures recorded in these ascents was -46° C. (-51° F.) at a height of 6,750 m. (22,000 feet)